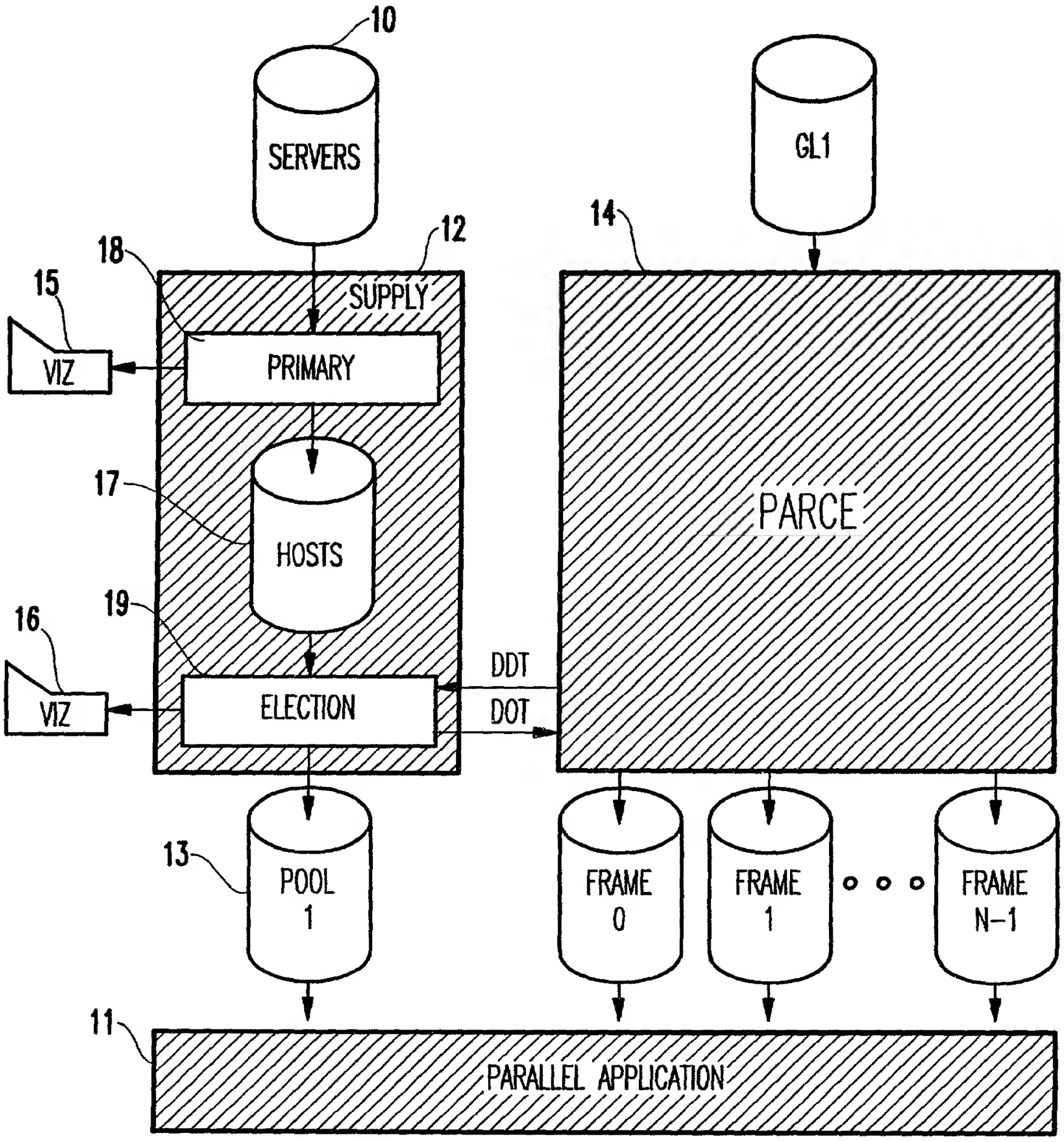

10
SERVERS
GL1
14
12
18
15
SUPPLY
VIZ
PRIMARY
17
HOSTS
PARCE
19
16
DDT
VIZ
ELECTION
DOT
13
POOL
1
FRAME
0
FRAME
1
FRAME
N-1
11
PARALLEL APPLICATION

FIG.1

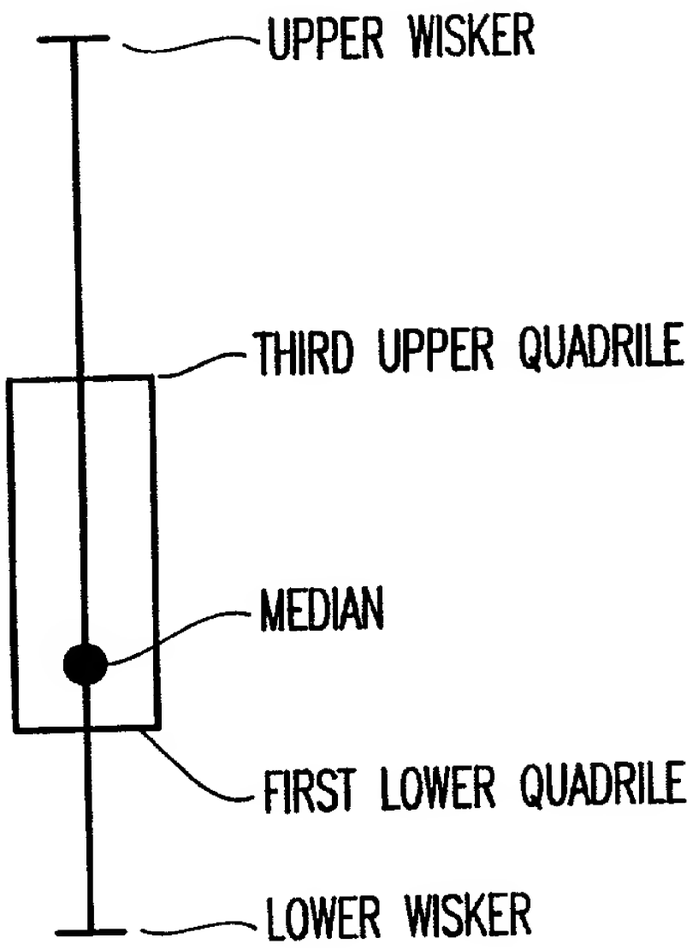

UPPER WISKER
THIRD UPPER QUADRILE
MEDIAN
FIRST LOWER QUADRILE
LOWER WISKER

FIG.2

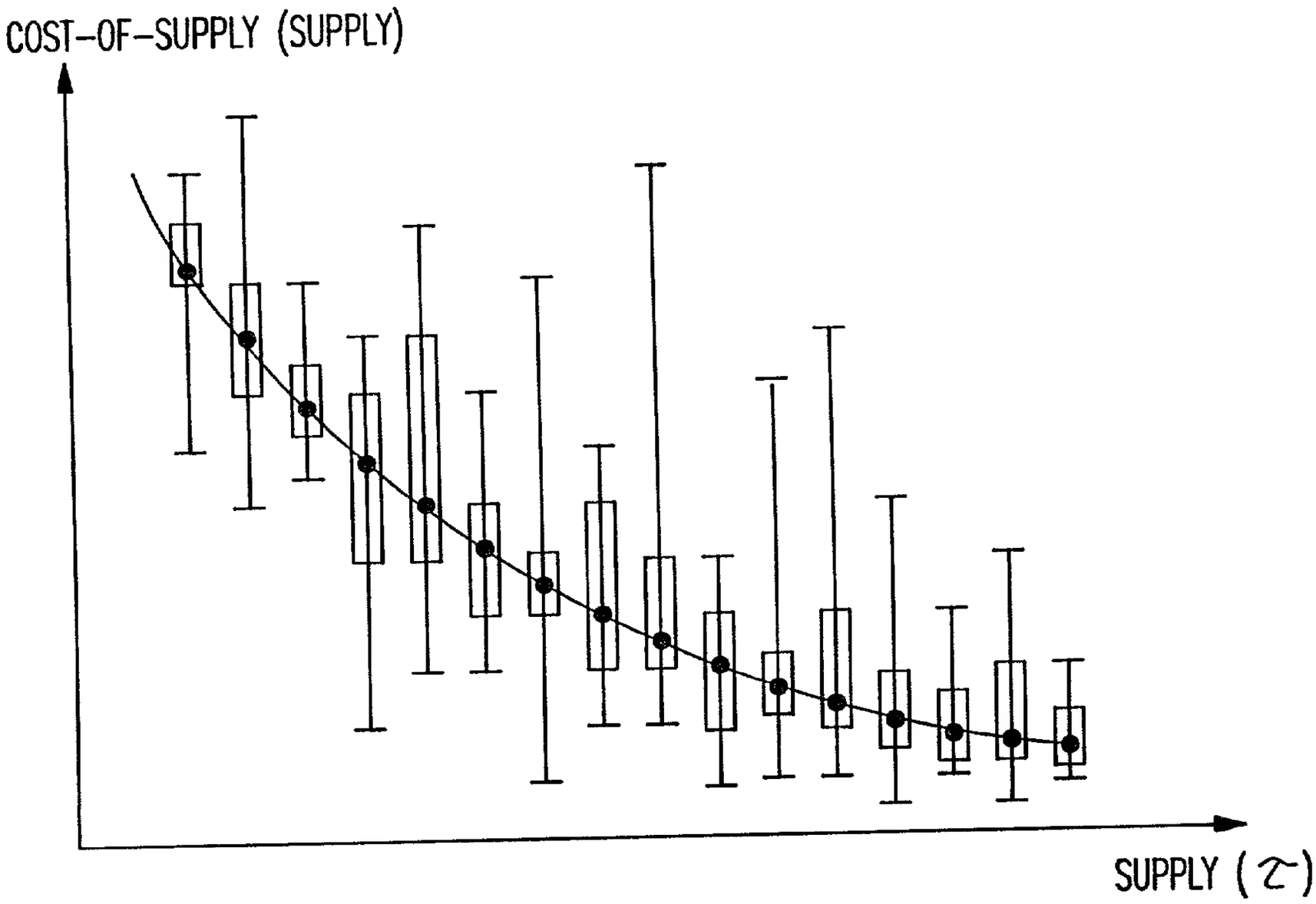

COST-OF-SUPPLY (SUPPLY)
SUPPLY (τ)

FIG.3

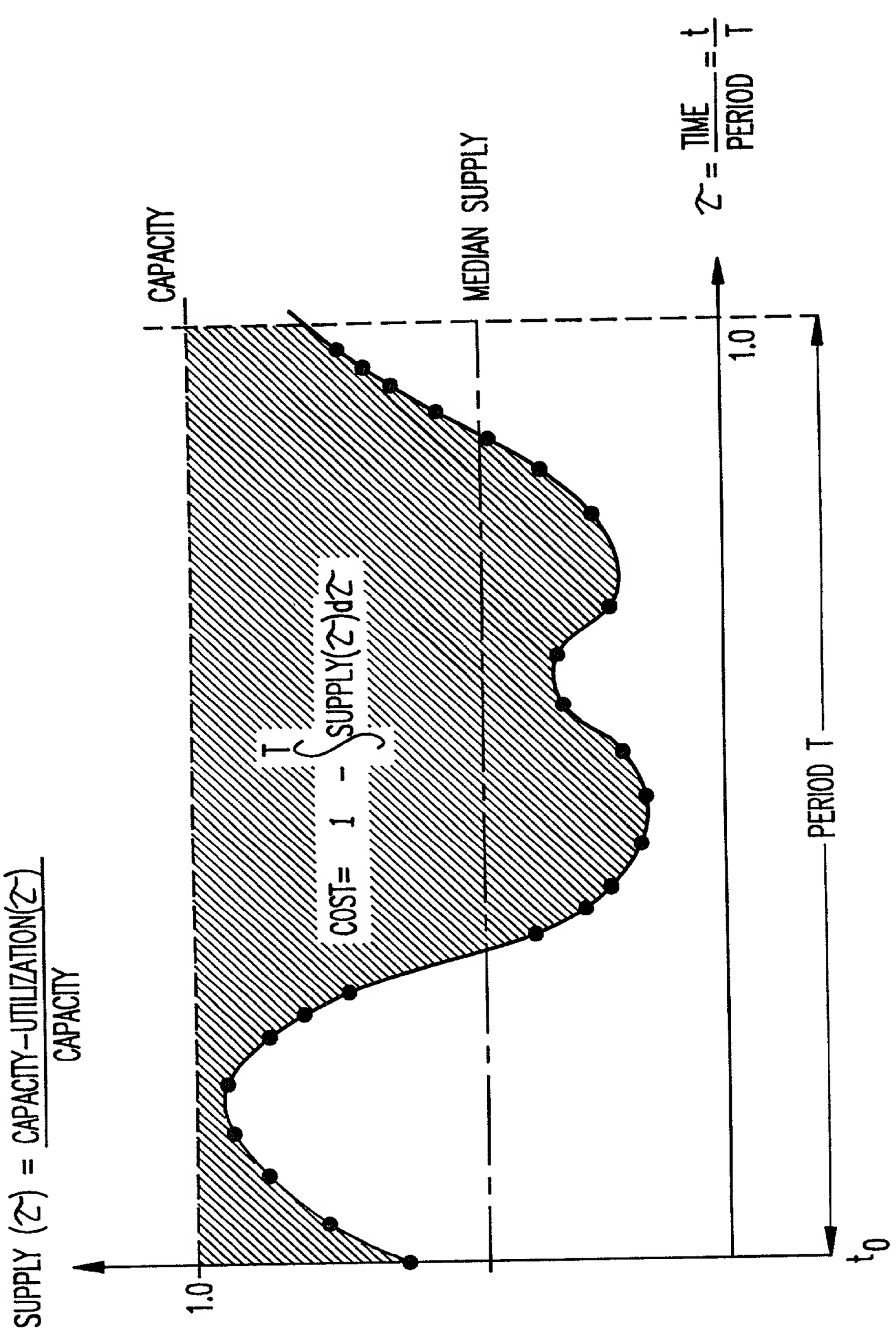

CAPACITY
MEDIAN SUPPLY
$\tau = \frac{\text{TIME}}{\text{PERIOD}} = \frac{t}{T}$
1.0
COST = 1 - $\frac{1}{T}\int_{T} \text{SUPPLY}(\tau)d\tau$
PERIOD T
SUPPLY (τ) = $\frac{\text{CAPACITY}-\text{UTILIZATION}(\tau)}{\text{CAPACITY}}$
1.0
t_0

FIG. 4

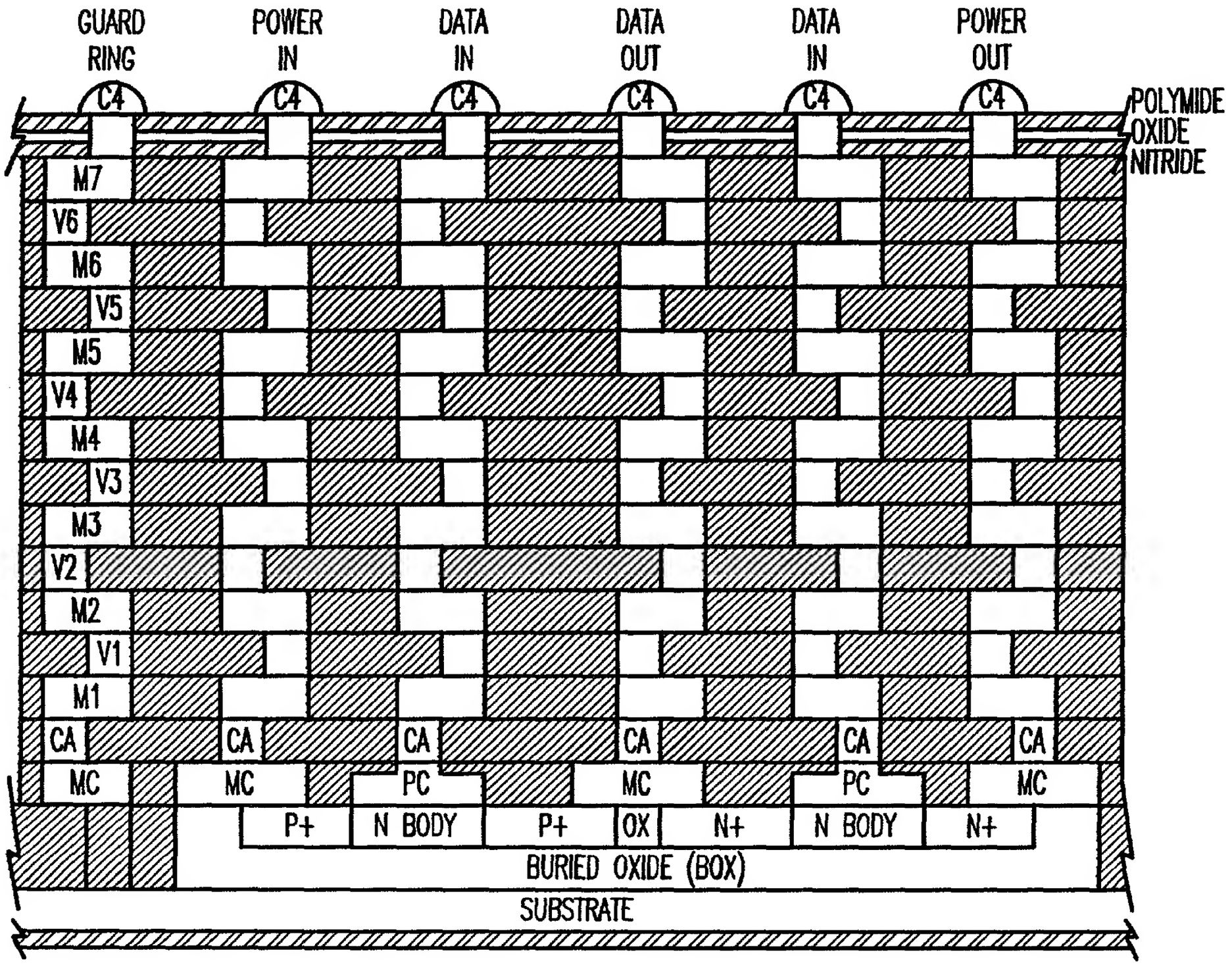

GUARD RING
POWER IN
DATA IN
DATA OUT
DATA IN
POWER OUT
C4
POLYMIDE
OXIDE
NITRIDE
M7
V6
M6
V5
M5
V4
M4
V3
M3
V2
M2
V1
M1
CA
MC
PC
P+
N BODY
OX
N+
BURIED OXIDE (BOX)
SUBSTRATE
G
S
P
N
X
INTERCONNECT RESISTANCE

FIG.5

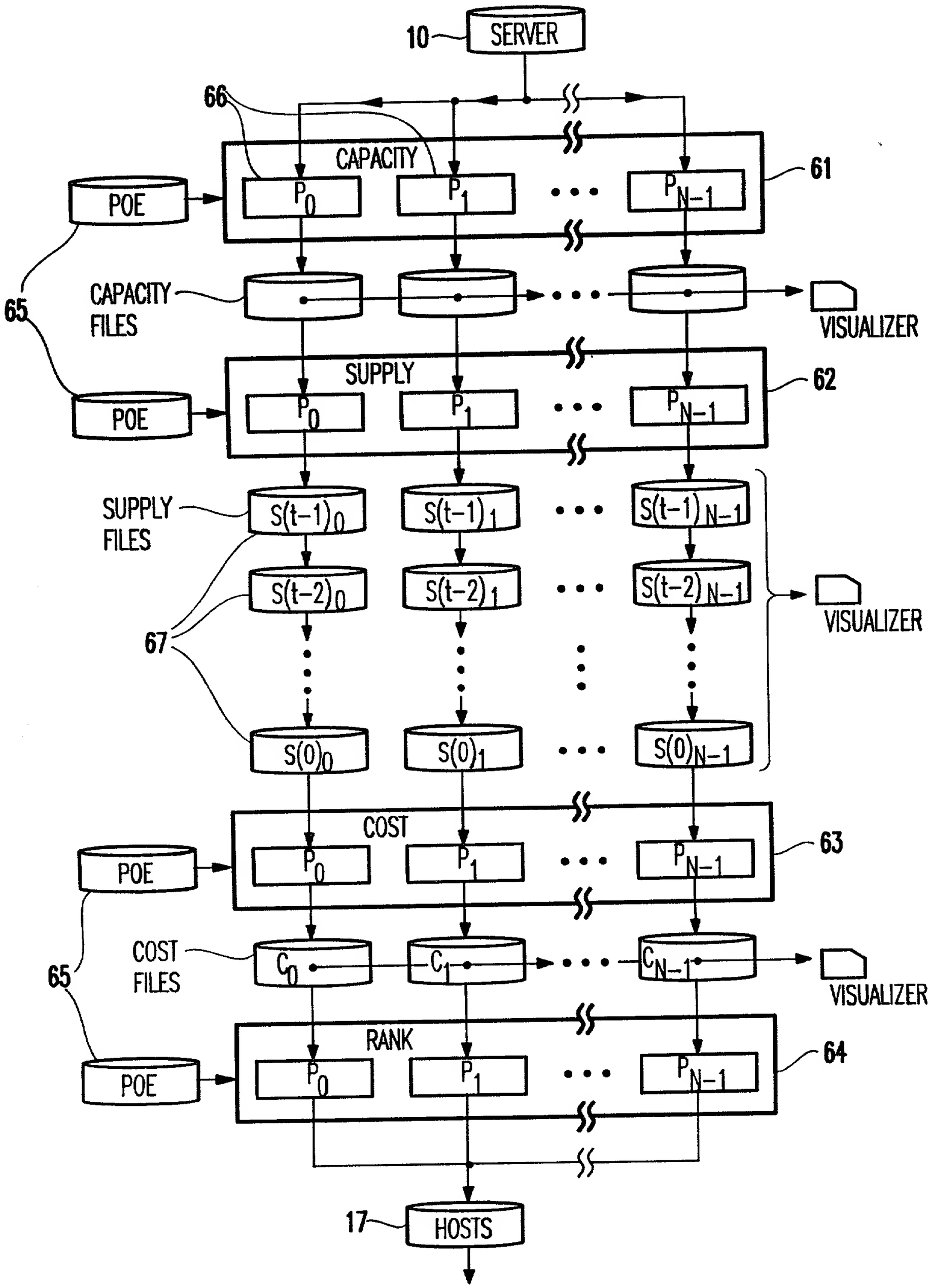
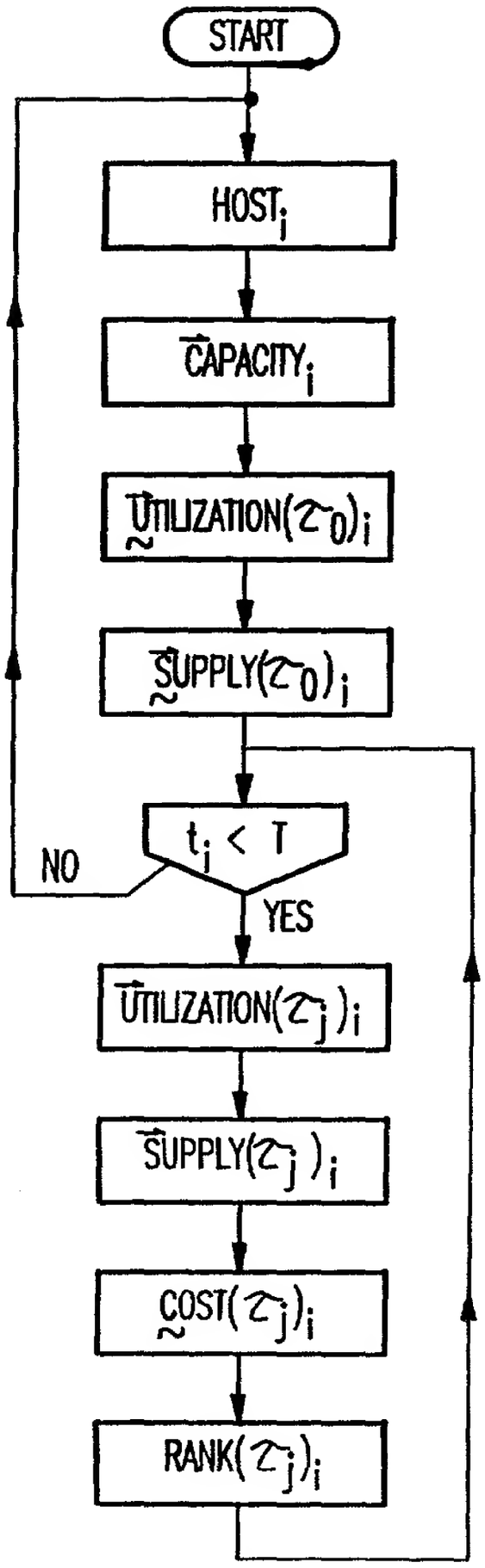

10
SERVER
66
CAPACITY
61
POE
P_0
P_1
P_{N-1}
CAPACITY FILES
65
VISUALIZER
SUPPLY
62
POE
P_0
P_1
P_{N-1}
SUPPLY FILES
$S(t-1)_0$
$S(t-1)_1$
$S(t-1)_{N-1}$
$S(t-2)_0$
$S(t-2)_1$
$S(t-2)_{N-1}$
67
$S(0)_0$
$S(0)_1$
$S(0)_{N-1}$
VISUALIZER
COST
63
POE
P_0
P_1
P_{N-1}
COST FILES
65
C_0
C_1
C_{N-1}
VISUALIZER
RANK
64
POE
P_0
P_1
P_{N-1}
17
HOSTS

FIG.6



$\vec{H}OSTS_i$ WHERE { DIMENSION: $0 \leq \vec{H}OST(i) \leq \vec{S}ERVER(N)$; UNIT SCALAR; FORM: TIME INDEPENDENT VECTOR(i), $0 \leq i < M \leq N$ } [1]

$\vec{C}APACITY_i = (CPU, MEMORY, TEMP\ FILE, CACHE\ PAGE)_i$ [2]

WHERE { DIMENSIONS: CPU, DATA, DATA, DATA; UNITS: SCALAR, BYTE, BYTE, BYTE; FORM: TIME INDEPENDENT, ix4 MATRIX }

$\vec{U}TILIZATION(t_0)_i = (CPU, MEM, TMP, PAGE)(t_0)_i$ [3]

WHERE { DIMENSIONS: CPU, DATA, DATA, DATA; UNITS: SCALAR, BYTE, BYTE, BYTE; FORM: TIME DEPENDENT, ix4 MATRIX }

$\vec{S}UPPLY(\tau_0)_i = \vec{C}APACITY_i - \vec{U}TILIZATION(\tau_0)_i$ [4]

WHERE { DIMENSIONS: CPU, DATA, DATA, DATA; UNITS: SCALAR, BYTE, BYTE, BYTE; FORM: TIME DEPENDENT, ix4 MATRIX }

WHERE $0 \leq \tau_j \leq$ SAMPLING PERIOD T

$\vec{U}TILIZATION(\tau_j)$ [3a]

$\vec{S}UPPLY(\ \ )_i = (\vec{C}APACITY_i - \vec{U}TILIZATION(\tau_j)_i)$ [4a]

$\tilde{C}OST_i = 1 - \int \tilde{S}UPPLY(\tau_j)_i\, dj_i$ [5a]

WHERE { DIMENSION: NONE, NONE, NONE, NONE; UNITS: SCALAR, SCALAR, SCALAR, SCALAR; FORM: TIME DEPENDENT VECTOR $(t_j)_i$ }

$\vec{R}ANK(t_j)_i = SORT[\vec{V}ALUE(t_j)_i]$ [6a]

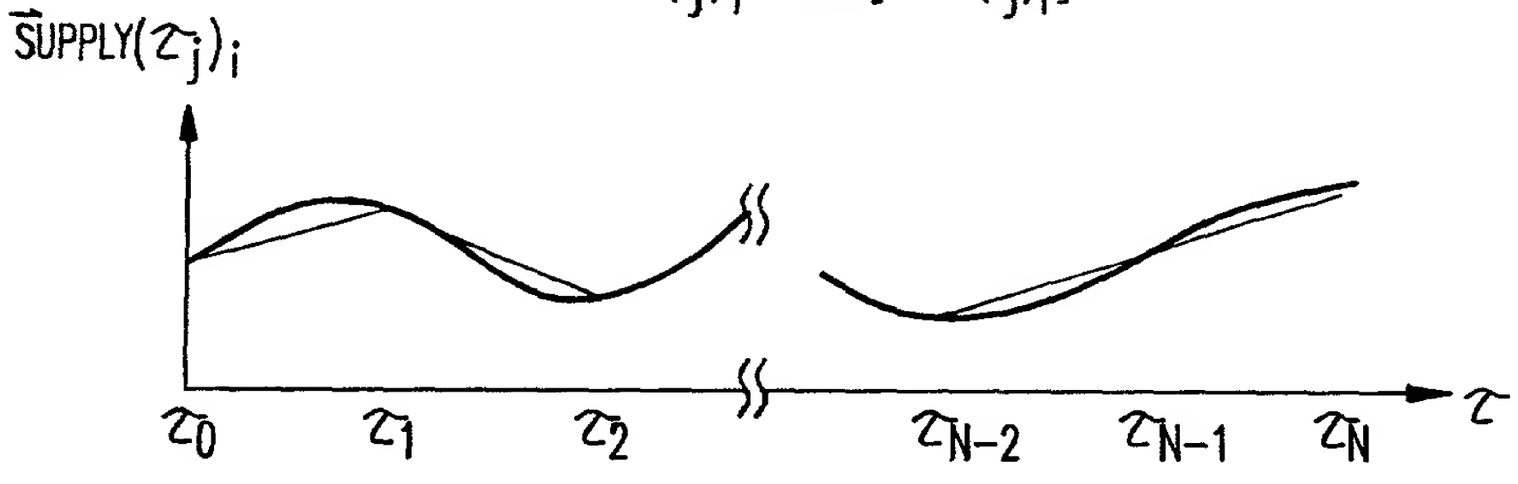


FIG.7

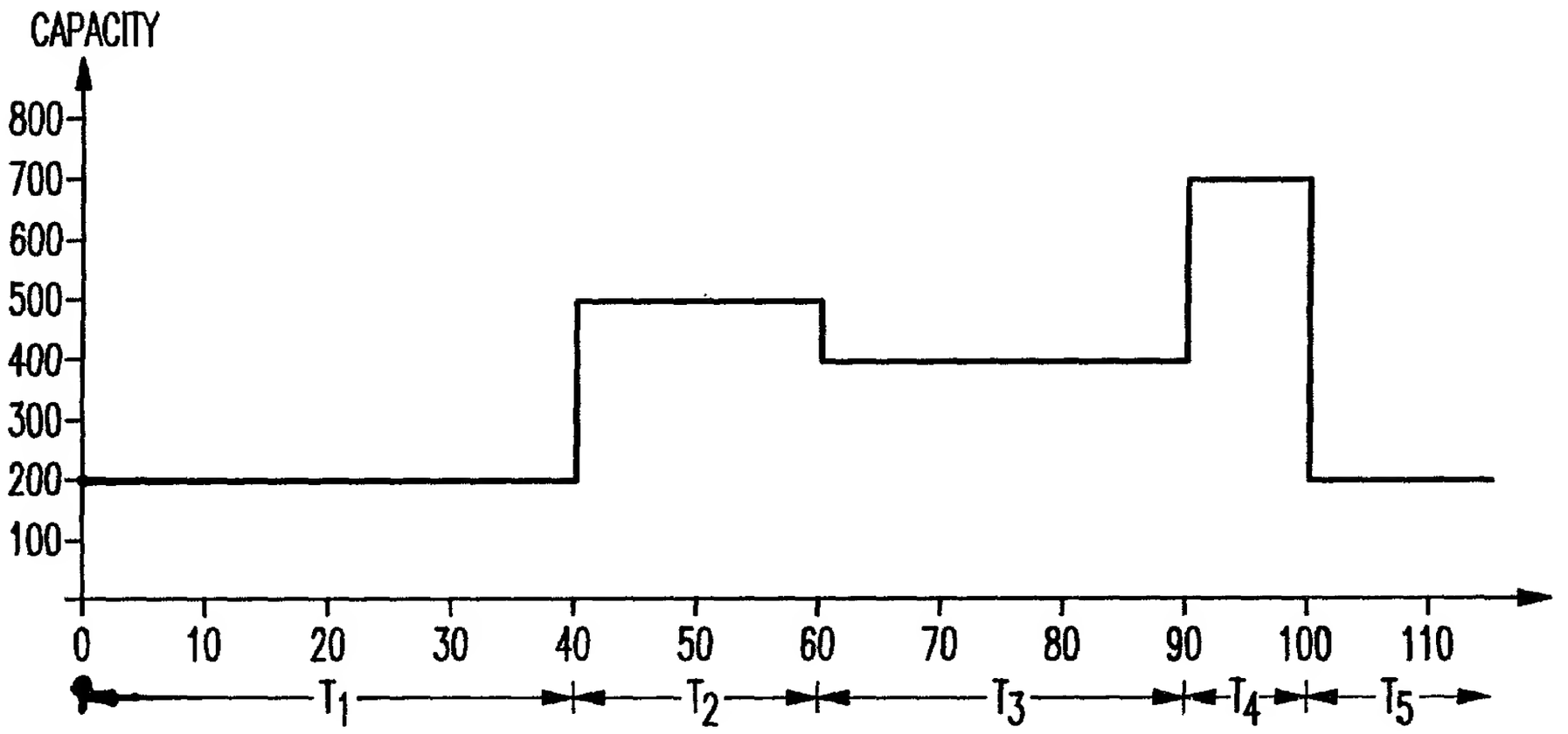

CAPACITY
800
700
600
500
400
300
200
100
0
10
20
30
40
50
60
70
80
90
100
110
T1
T2
T3
T4
T5

FIG.7A

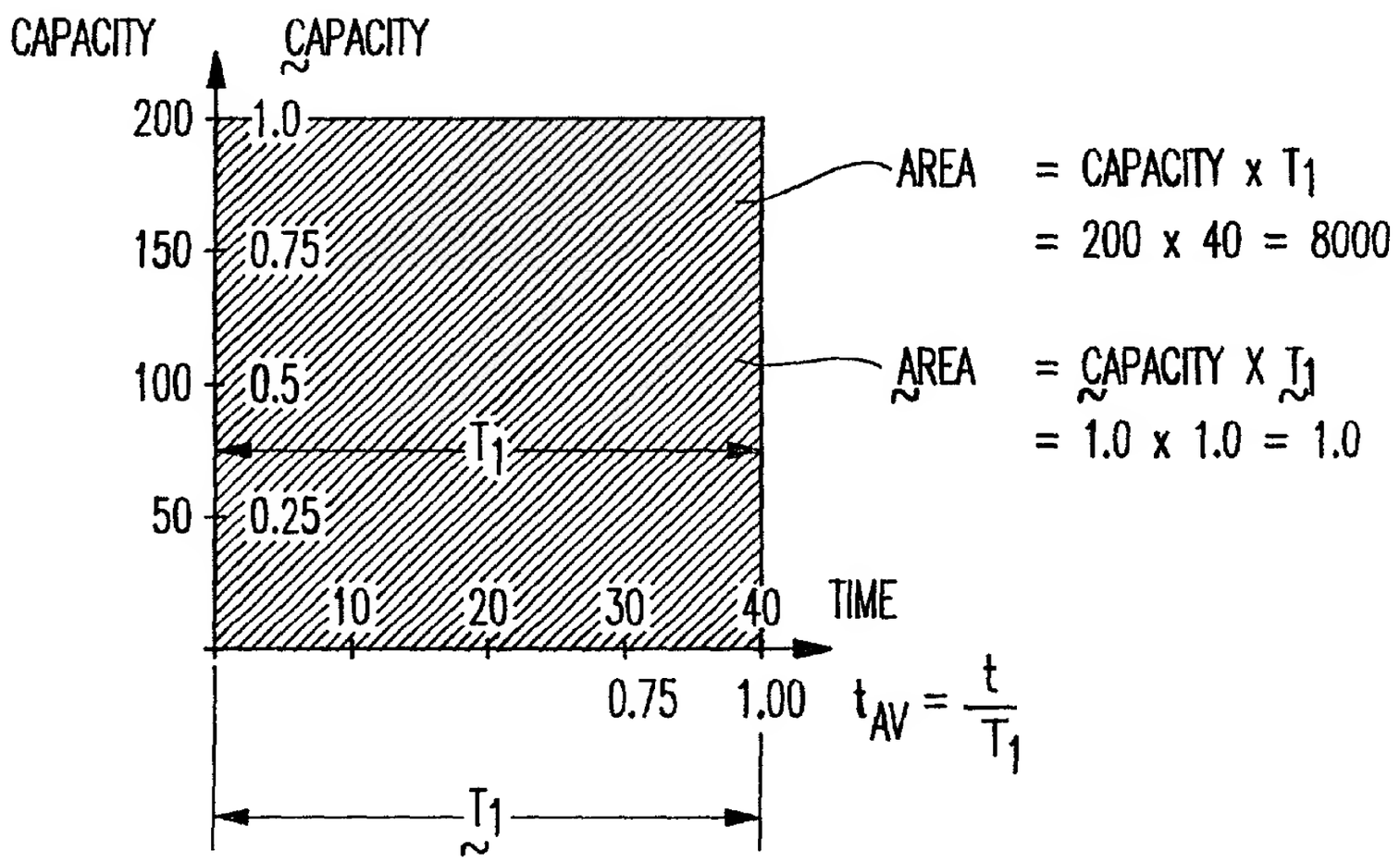

CAPACITY
CAPACITY
200
150
100
50
1.0
0.75
0.5
0.25
T1
10
20
30
40
TIME
0.75
1.00
AREA = CAPACITY x T1
= 200 x 40 = 8000
AREA = CAPACITY X T1
= 1.0 x 1.0 = 1.0
tAV = t/T1
T1

FIG.7B

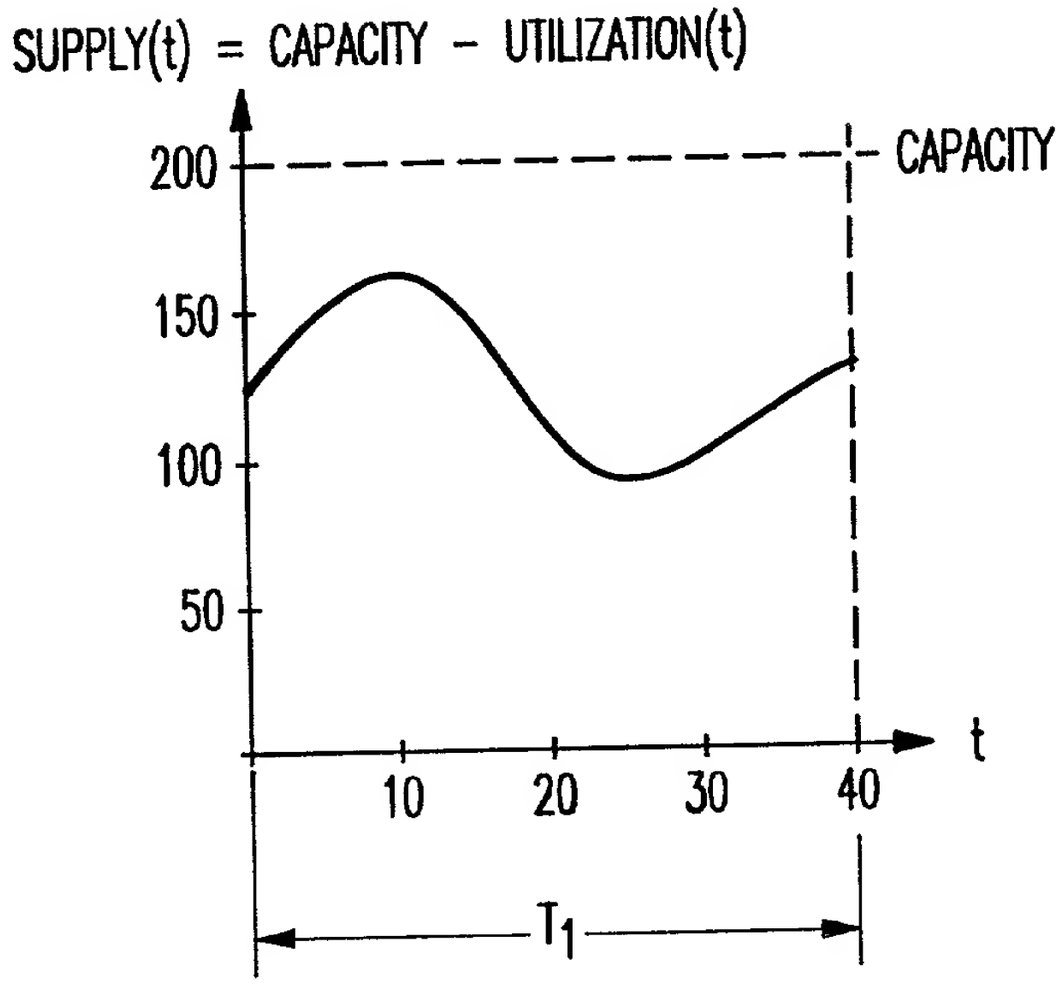

SUPPLY(t) = CAPACITY - UTILIZATION(t)
200
150
100
50
CAPACITY
t
10
20
30
40
T1

FIG.7C

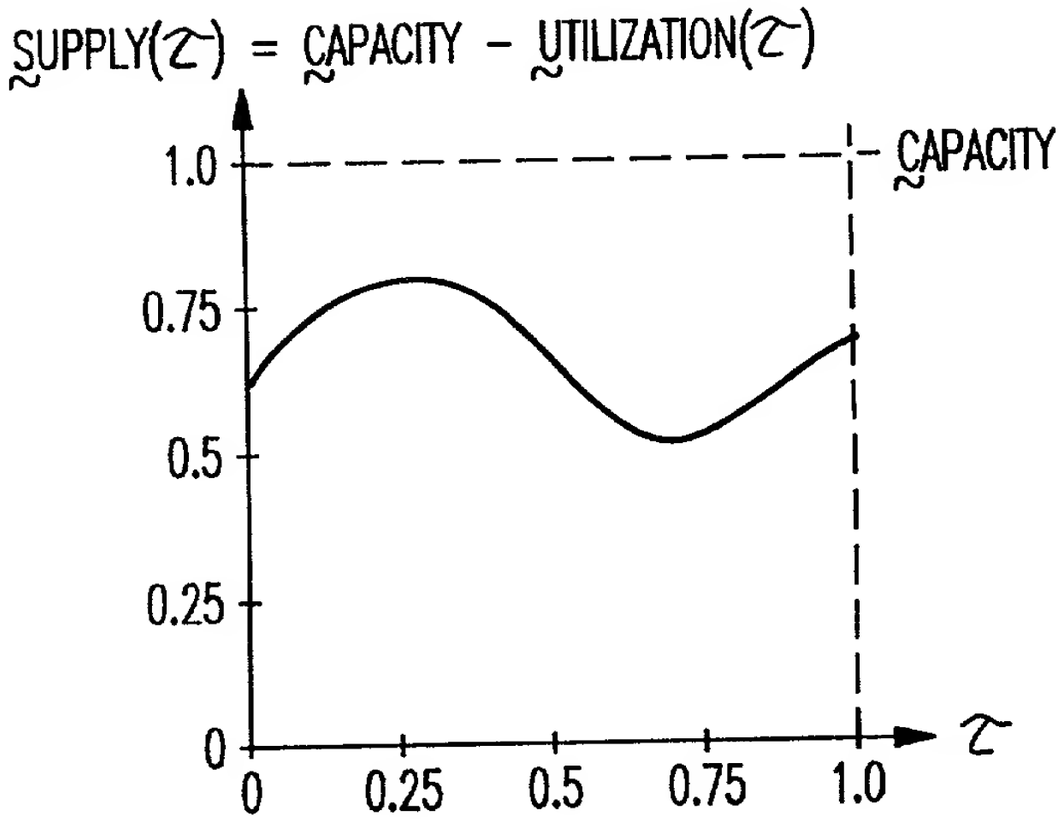

SUPPLY(τ) = CAPACITY - UTILIZATION(τ)
1.0
0.75
0.5
0.25
0
CAPACITY
τ
0
0.25
0.5
0.75
1.0

FIG.7D

$$\frac{d}{d\tau}\text{COST-OF-}\underset{\sim}{\text{SUPPLY}} = \underset{\sim}{\text{SUPPLY}}(\tau)\begin{cases}\frac{d}{d\tau}\text{COST-OF-}\underset{\sim}{\text{SUPPLY}}(\tau)\uparrow \Rightarrow \downarrow \underset{\sim}{\text{SUPPLY}}(\tau)\\ \frac{d}{d\tau}\text{COST-OF-SUPPLY}(\tau)\downarrow \Rightarrow \uparrow \text{SUPPLY}(\tau)\end{cases}$$

FIG.7E

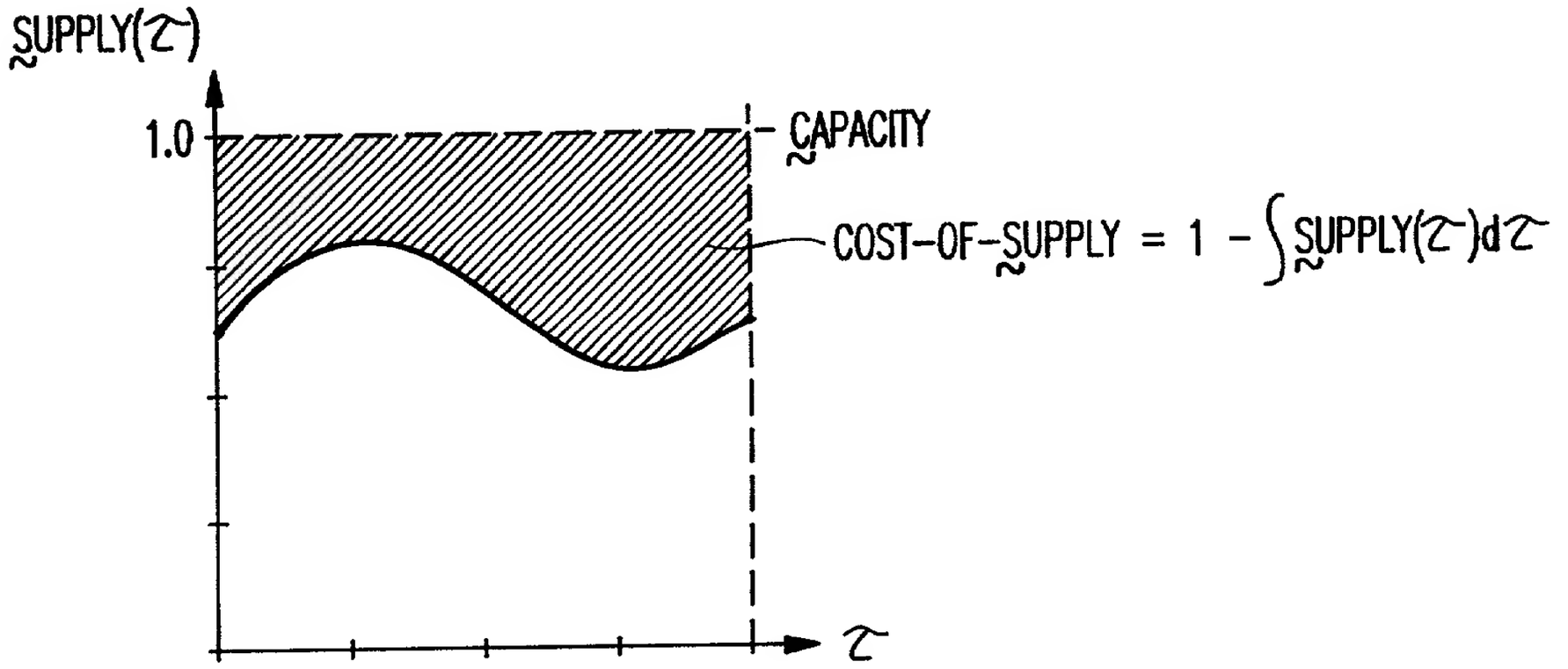


FIG.7F

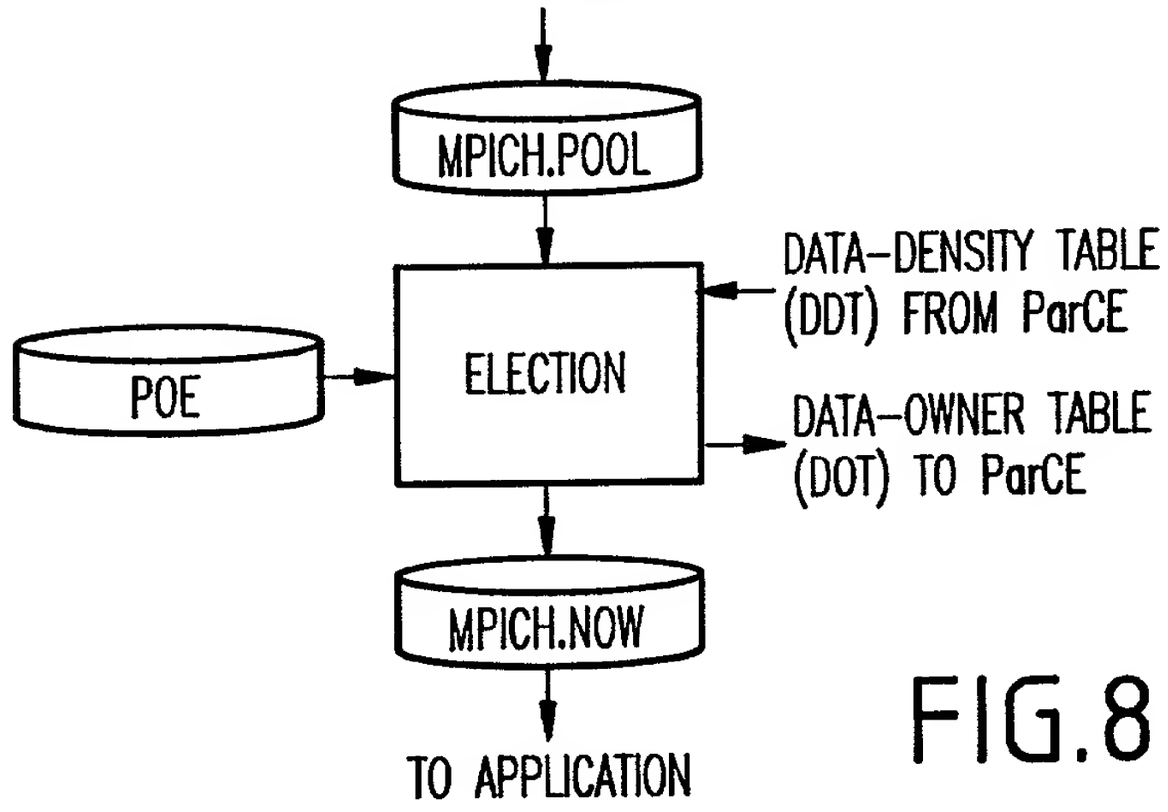


FIG.8

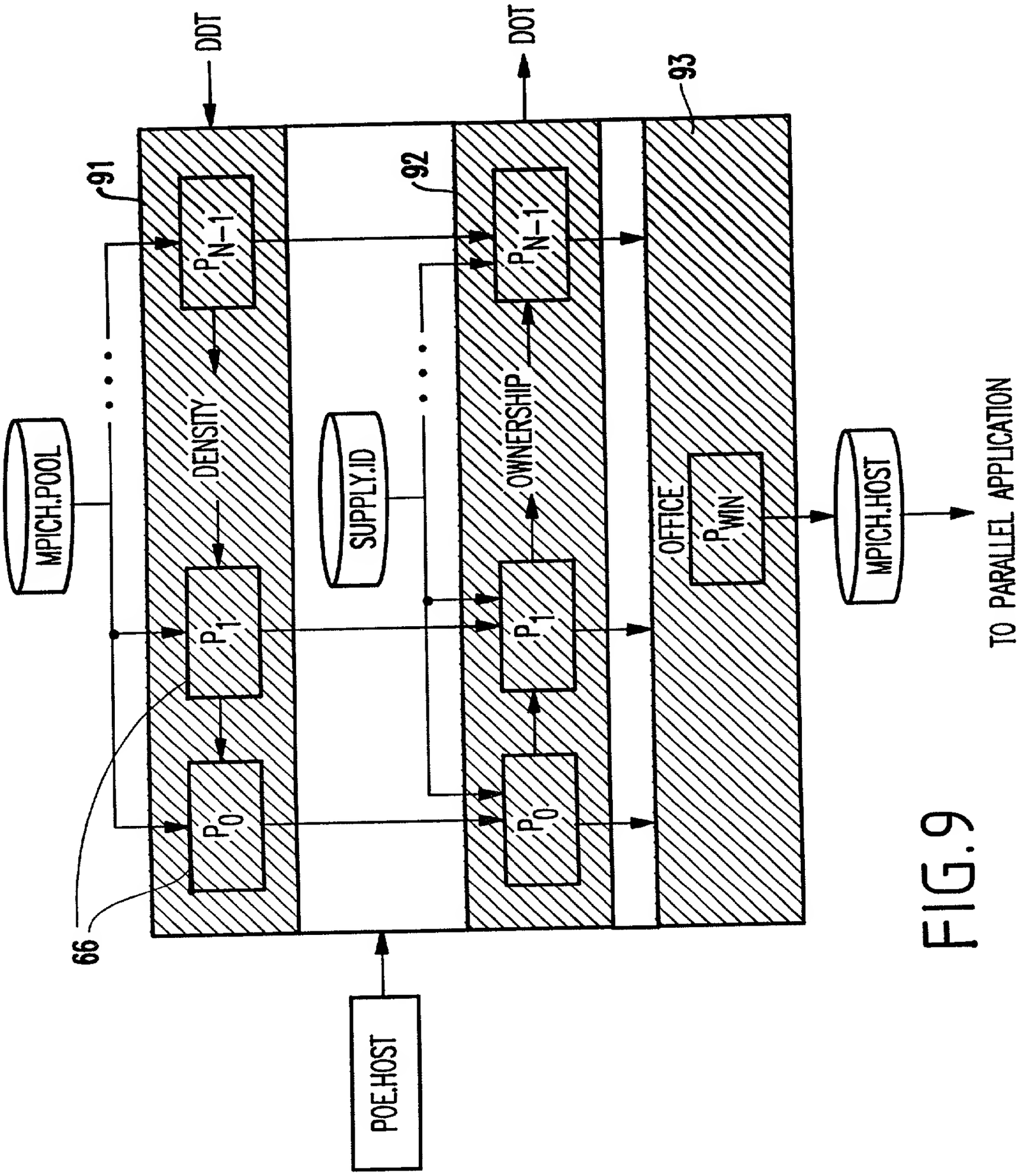

DDT
DOT
93
91
92
P_{N-1}
P_{N-1}
MPICH.POOL
DENSITY
SUPPLY.ID
OWNERSHIP
OFFICE
P_1
P_0
P_1
P_0
P_{WIN}
MPICH.HOST
TO PARALLEL APPLICATION
66
POE.HOST

FIG.9

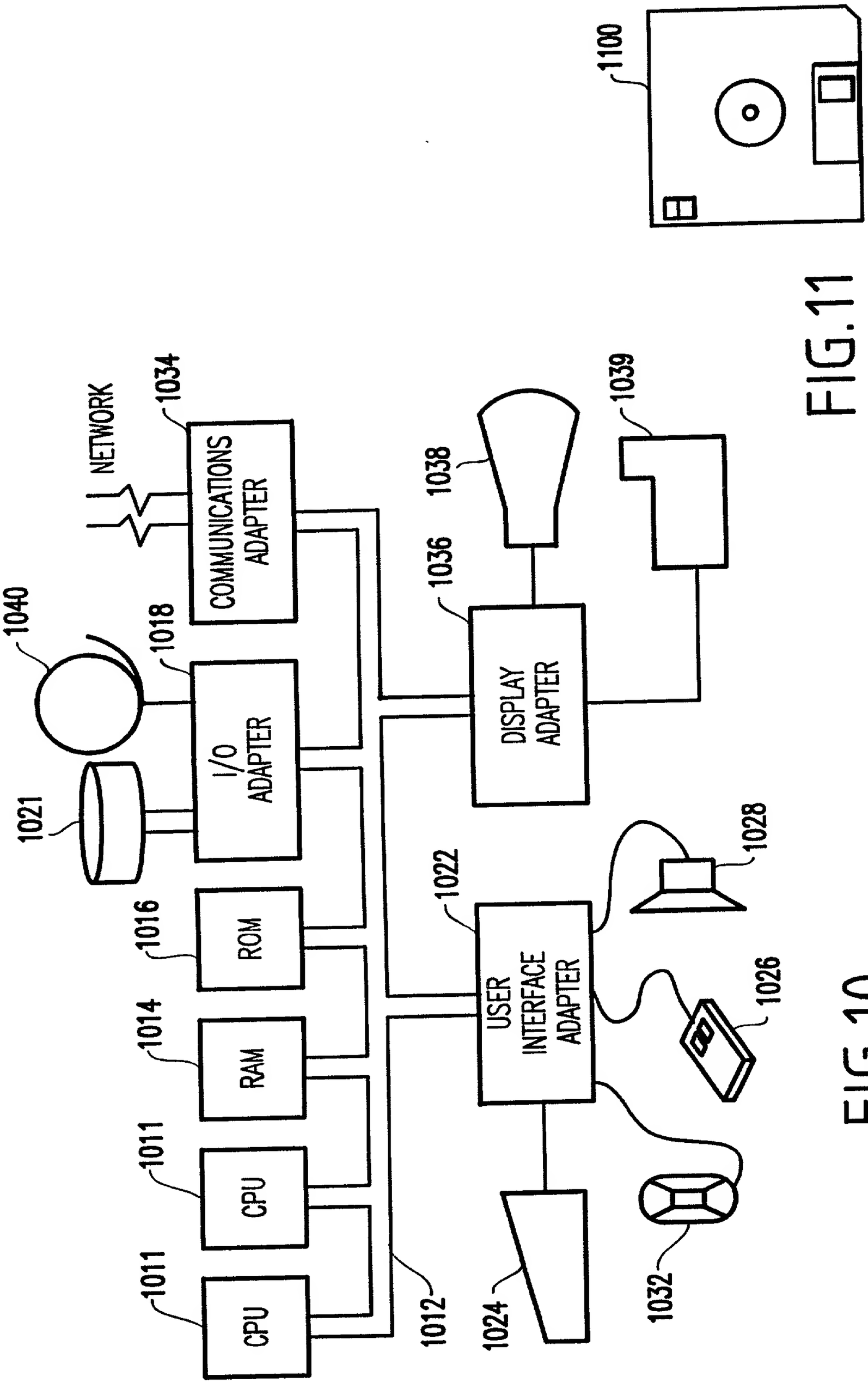

1100
1034
NETWORK
COMMUNICATIONS ADAPTER
1040
1018
I/O ADAPTER
1021
1016
ROM
1014
RAM
1011
CPU
1011
CPU
1012
1036
DISPLAY ADAPTER
1038
1039
1022
USER INTERFACE ADAPTER
1028
1026
1024
1032

FIG.10